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AUTHOR Beyer, Francine S.
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INSTITUTION Research for Better Schools, Inc., Philadelphia, Pa.
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ABSTRACT

A study determined whether participation in a project using personal computers in the classroom to teach the writing process enabled students to improve their writing performance. One middle school from each of Delaware's 16 districts participated in the program. The project goals were incorporated into a set of four process and three outcome evaluation questions which formed the framework for the evaluation design. Results indicated that: (1) adequate orientation and training were provided to the schools; (2) most program sites started on time and implemented the program as planned; (3) a few of the schools did not take advantage of the special training opportunities and technical services offered; (4) on-site evaluation and monitoring of the first year was essential; (5) students' writing skills were enhanced through the use of computers within the context of the process approach to writing; (6) students enjoyed writing more when using computers in conjunction with their normal writing instruction program; (7) students enjoyed using the computer for learning and practicing their writing skills; (8) teachers enjoyed using the computer for writing instruction; (9) variables fostering continued implementation were support from the school district, teachers' increased knowledge and comfort, and student interest in and support of the practice; and (10) variables mitigating against the program were the limited number of computers, lack of school or district support, large class size, and lack of student interest. (Six tables of data and a figure describing the evaluation design are included.) (RS)

Impact of Computers on Middle-Level Student Writing Skills

by

Francine S. Beyer

Research for Better Schools, Inc.
444 North Third Street
Philadelphia, PA 19123

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Introduction

The definition of literacy, which is commonly agreed to be a major educational goal for our students, has changed. It is no longer merely the acquisition of the basic skills of reading and writing, but now includes the thoughtful use of skills such as reading, writing, speaking, and listening (Brown, 1987). Calfee (1992) describes this new focus as the development of critical literacy, "the capacity to use language in all its forms as a tool for thinking, problem solving, and communicating" (p. 148). Whatever definition one adopts, this educational goal is not being met.

One of the most depressing accounts of America's failure to develop literate abilities in our students is the results of NAEP's 1984 and 1988 national assessments of representative samples of fourth, eighth, and eleventh grade students' performance on various writing tasks (Applebee, Langer, & Mullis, 1988; Applebee, Langer, Mullis, & Jenkins, 1990). These studies found that most of the 18,000 students sampled knew some or all of the basic elements needed to complete the writing tasks but were unable to provide "adequate" responses that reflected using the elements to effectively accomplish the tasks. Also, there was little improvement in writing levels across the four year period. Along with their poor performance, most students did not report having positive attitudes toward writing. Another salient finding was a trend for teachers to use process-oriented instructional activities, although whether or not students used these instructional strategies effectively, frequently, and with understanding was unclear. However, the NAEP results did suggest that when students plan, revise, and edit they are more likely to be better writers.

The Delaware Department of Public Instruction (DPI) identified a state need to improve student writing performance and, based on the state's

Additionally, it was anticipated that the project would have a positive impact on teachers in their classroom instruction. These three hypotheses guided the development of the evaluation design.

The program had five principal components or key elements:

- teacher daily use of the writing process approach to teaching writing, focusing on the stages of pre-writing, drafting, and revising
- teacher daily use of all computers for students, on a rotating basis, to work through their writing assignments
- teacher daily use of a short writing lesson or mini-lesson, thus allowing students to spend most of their class time working on writing assignments
- teacher daily use of conferencing, with individuals or small groups of students, to encourage students' writing
- teacher on-going monitoring of students working on the computer and on writing assignments, to be aware of their progress and needs for assistance.

Each of the five components of the program needed to be carried out effectively if the desired outcomes were to be realized.

Design and Procedures

The computer writing project was implemented in each of sixteen school districts throughout Delaware. Writing teachers in each of the selected middle schools (one per district) participated and received at least six computers, one printer, and writing software. All hardware/software selections were made by the teacher in conjunction with local administrators. In addition, thirteen of the sixteen participating schools provided a control group for the study. These control groups were selected on the basis of comparability of teachers and students and on the expectation that the control students would have limited exposure to the use of the computer in learning writing skills.

There were five stages to the project, each of which was to be evaluated. They were: 1) orientation of participating teachers, 2) selection and acquisition of hardware and software, 3) training of participating teachers, 4) implementation, and 5) continuation. The first three stages were completed during the spring and summer of 1989. Then, teachers began, early in the school year, to use the computers in their daily instructional activities. Throughout the 1989-1990 school year, teachers were monitored and were provided with technical assistance and support as needed. A follow-up evaluation at the end of year two, the 1990-1991 school year, looked at the continuation of the sixteen original implementations.

Evaluation Design

The project goals were incorporated into a set of four process and three outcome evaluation questions which formed the framework for the evaluation design. This framework is outlined in Figure 1.

The process component of the evaluation was to focus on insuring that prerequisite conditions for proper program implementation were met. It was therefore designed to study the course of the five stages of the project, to document their progress, and to assess the quality of their associated activities. Feedback from the process evaluation was to be used by project administrators and staff to adjust and fine-tune project activities in order to make the activities more effective.

The outcome component of the evaluation was designed to assess the effects of the project on student writing skills and on student attitudes toward writing and toward using the computer for writing. A pretest-posttest control group design was used to enhance the validity of the findings. Guidelines for selecting the control or comparison group for each

Figure 1

EVALUATION DESIGN

Process Evaluation

Evaluation Question	Measure	Expectation
Orientation - Was adequate orientation and assistance provided for planning and selection of hardware/software?	• Readiness Checklist • Teacher Inservice Evaluation Form	• Commitment and support for the project. • Ready to explore hardware/ software options. • Training needs identified
Selection and Acquisition - Was the appropriate hardware and software ordered and delivered on time?	• School Hardware/Software Decisions Form • Telephone Readiness Checklist	• Necessary and appropriate hardware/software selected, ordered, and received by September.
Training - Was adequate inservice training in computer literacy, the writing process, and the use of computers in teaching writing provided to project teachers?	• Software Training Evaluation Form • Teacher Inservice Evaluation Form	• Training needs met. • Implementation concerns identifed. • Any outstanding needs to be met by September 1.
Implementation - Did the teachers start-up on time and implement the key program elements (writing process approach, computer use, mini-lessions, conferencing, monitoring)?	• Telephone Readiness Checklist • Classroom Observation Form • Teachers Log • Teacher Feedback	• All training, hardware, and software needs satisfied. • Program on schedule for start-up in September. • Regular use of key program elements in classroom by all teachers.
Continuation - Did the original program implementations continue and what mitigated against/ fostered continuation/expansion?	• Teacher Follow-up Survey	• Continued use of key program elements in classroom by all teachers (at the same or increased levels).

EVALUATION DESIGN (continued)

Outcome Evaluation

Evaluation Question	Measure	Expectation
Writing Skills - Were student writing skills enhanced as a result of participation in the project?	• Pre- and Post- Writing Assessment • Pre- and Post- Student Survey	• Significantly greater writing proficiency in program group over comparison group. • Significantly improved writing skills by self-report in program group over comparison group.
Enjoyment of Writing - Did students get more enjoyment out of writing as a result of participation in the project?	• Pre- and Post- Student Survey • Teacher Anecdotes	• Significantly enhanced enjoyment of writing by self-report in program group over comparison group. • Teacher reports of students' enhanced enjoyment of writing.
Enjoyment of Computer Learning - Did students enjoy using the computer for learning and practicing writing skills?	• Pre- and Post- Student Survey • Teacher Anecdotes	• Student responses indicate enjoyment in using the computer for writing assignments. • Teacher reports of students' enjoyment of using the computer for writing.

project class included specifications that the two groups be as similar as possible on key characteristics (i.e., type of student, achievement levels, demographic variables). Feedback from the outcome evaluation was to document overall program effectiveness and to provide information useful in making decisions about project expansion or replication.

Procedures

Figure 1 describes the process and outcome evaluation design in terms of evaluation questions, measures, and expectations for each of the four stages of the project. The evaluation procedures associated with the five process and three outcome evaluation questions are described below.

Orientation. The sixteen project teachers and several of their school administrators participated in a two-day workshop in the spring of 1989. The workshop was designed to provide an orientation to the project, and an overview of writing software, computer hardware, and approaches for using the computer to assist with writing instruction. During the first orientation session, teachers were administered the Readiness Checklist to determine their district/school's readiness to participate in the project. At the conclusion of the second day of the orientation workshop, participants were administered the Inservice Evaluation Form to obtain feedback on the orientation sessions and also to assess their readiness to select the necessary hardware and software for the project.

A separate orientation session was held for principals and computer coordinators from the sixteen middle schools. This session was designed to provide administrators with an overview of the project and the required implementation tasks (e.g., to participate in hardware and software selection) and to address any concerns or questions that might arise prior to implementation. This activity was observed and evaluated by RBS staff.

Selection and Acquisition. In June, a School Hardware/Software Decisions Form was completed by administrators in each district in conjunction with the project teacher, indicating the type of computer hardware and software package(s) the districts decided to purchase for the project. As a follow-up, a Telephone Readiness Checklist was used to determine whether the hardware and software ordered had been received, set-up, tested, and was ready to be used for instruction.

Training. The Teacher Inservice Evaluation Form served as a vehicle for identifying teacher need for further training on computer hardware, software, or on the writing process. To respond to these identified needs, two August workshops were held; the DPI conducted a fifteen hour course on the Delaware Writing Process for which teachers received one inservice credit, and fifteen hours of training on the specific hardware and software teachers selected was provided by DPI staff, RBS staff, and representatives from computer vendors. At the conclusion of the workshops, RBS administered a Software Training Evaluation Form to assess the effectiveness of the training and to identify additional needs, if any.

Implementation. The implementation of the project was addressed by the process and outcome evaluation components. The process evaluation focused on monitoring teacher use of the five program elements (i.e., the writing process, the computers, mini-lessons, conferencing, and monitoring). Information was collected through three process evaluation activities, classroom observations, teacher logs, and follow-up meetings. Initial information on start-up dates for implementing the program was obtained by telephone calls to principals of the participating schools early in the school year.

A Classroom Observation Form was developed to collect information during observations of participating teacher classrooms. Three rounds of observations were conducted, at the beginning, the middle, and the end of the school year. Teachers' self-report data on their implementation of the program elements was documented through a Teacher Log and through discussions at follow-up meetings. Three follow-up dinner meetings were convened during year one, and another meeting was held during year two. The meetings were designed to: 1) facilitate sharing/communication among project participants, 2) identify any additional assistance and support needed by participants to implement the project, and 3) develop plans to provide the needed assistance in a timely fashion.

Continuation. Due to the limited resources and time for conducting the follow-up evaluation of the computer writing project, the primary data source to address the continuation and possible expansion of the project was feedback from a teacher survey. The survey was to be administered to project teachers during a group meeting at the end of the 1990-1991 school year and would address implementation of the five program components, expansion within and outside of project classes, and factors supporting or constraining continuation and expansion.

The outcome evaluation focused on the impact of the project on student writing proficiency, and on student enjoyment of writing as well as using the computer for writing. As indicated previously, the evaluation plan incorporated a pretest-posttest control group design.

Writing Skills. In order to assess student writing skills, project and control teachers administered a Pre-Writing Assessment at the beginning of the school year, and a Post-Writing Assessment at the end of the school

year. The assessments required students to produce a short writing sample in response to the following prompts:

- "Think about one change that you would like to make in your school and why you would like to make that change. Give reasons why the change should be made, and explain how the change would benefit the school..." (Pre-Writing Assessment).

- "Think about one change that you would like to make in the town or city in which you live and why you would like to make that change. Give reasons why the change should be made, and explain how the change would benefit your town or city..." (Post-Writing Assessment).

These prompts were similar to those used in the 1985 Delaware Writing Assessment Project, and were determined to have the potential for producing a range of scorable student responses. They were also judged to be free of bias, interesting to students, and unambiguous.

Enjoyment of Writing and Computer Learning. Information on student attitudes was collected through a Student Survey attached to each writing assessment. Each survey consisted of the same eleven multiple choice items addressing student experiences with writing assignments and computer use. Additional impact data were obtained through teacher reports and anecdotes shared at follow-up meetings and during school visits and telephone contacts.

Results

The following section of the report presents the results of the data analysis. The findings are discussed in terms of the process and outcome evaluation questions.

Process Evaluation Results

The results of the process evaluation activities are reported with reference to the five process evaluation questions outlined in Figure 1.

Was adequate orientation and assistance provided for planning and selection of hardware/software? Thirteen project teachers attended the

two-day orientation session. The Readiness Checklist administered during the first day indicated that teacher's perceptions of the district/school leadership's commitment and support for the project, as well as the teachers' own commitment toward the project, were very high. The results also indicated that, while teachers had previously attended workshops on the writing process, they had only limited experience using a computer in personal writing tasks.

The results of the Teacher Inservice Evaluation Form, administered at the conclusion of the second day of the orientation workshop, were very positive. In terms of implementation readiness, respondents indicated an awareness of the writing process and how to use the computer to teach writing for classroom instruction. Although most teachers were exploring hardware and software options with administrators, a few indicated that either the selections were being made for them or that they were not able to contribute to the decisions. Most teachers also indicated a need for further training on the hardware, software, and -- to a lesser extent -- on the writing process. To address these training needs, a week-long workshop was scheduled for the end of August.

RBS's evaluation of the orientation session for principals and computer coordinators indicated that the objectives of the session were met. In addition, participants exhibited enthusiasm and support for the project.

Was the appropriate hardware and software ordered and delivered on time? The School Hardware/Software Decisions Form, completed by administrators in each district in conjunction with the project teacher, indicated that all sixteen schools selected and purchased at least six computers, one printer, and writing software by early June. In terms of the computer hardware, eight districts selected Apple MacIntosh computers (Plus,

SE, II), five selected Apple IIe computers, one district selected Smart Micro (IBM compatible), one selected Apple IIGS, and one selected Hyundai. The writing software selected and ordered to support implementation of the project included: Writer's Helper II (seven districts), Success with Writing (two districts), and Bank Street Writer III (two districts). Also, each of the following word processing software packages was selected by two districts: MacWrite, Word, Wordbench, WordPerfect, and Works.

The results of the Telephone Readiness Checklist show only two principals indicating that their project teachers definitely needed additional hardware and software training; all principals felt that training on the writing process was sufficient. In most cases, the hardware and software had been received and set-up, and only one principal reported that the equipment had not been tested. A few principals, however, reported minor problems (e.g., all materials -- software, printers, discs -- not received, electrical hook-ups and computer tables needed, defective monitor). These problems were followed-up by RBS and the DPI.

Was adequate inservice training in computer literacy, the writing process, and the use of computers in teaching writing provided to project teachers? Nine project teachers participated in the workshop on the hardware and selected software. Feedback on the Software Training Evaluation Form showed that high ratings were given to both the sessions and the presenters. Overall, teachers felt that they received the support they needed for using the hardware and software. In terms of implementation readiness, they reported feeling comfortable with using the software for the writing and revising stages, but a little less comfortable with using the software for prewriting or planning. Although most teachers felt that they needed additional practice, their major concern seemed to be with managing a

classroom which contained computers. These concerns were monitored by the DPI and RBS through school visits and personal contacts.

Did the teachers start-up on time and implement the key program elements? Program start-up dates were provided by principals as part of the Telephone Readiness Checklist, administered in late August. Eight principals indicated the start-up date for implementing the program would be in September, and eight indicated the program would start "as soon as possible." The DPI and RBS continued to monitor each teacher's progress in beginning implementation. Although most teachers began using their computers by October, the initial start-up generally involved several weeks of "trouble-shooting" (i.e., setting-up the classroom, debugging software, managing the classroom, ordering materials, maintaining Teacher Logs).

Information on program implementation was collected through conducting classroom observations, using the Classroom Observation Form, reviewing Teacher Logs, and discussing the project with teachers and students. Although the Logs were scanned during observations and requested for submission at the end of the school year, only half of the project teachers recorded this information on a regular basis; the remaining teachers reported it was difficult to find time to recall and enter the required information in the typical "hectic" school day. However, those who did maintain the Teacher Log indicated that it provided useful information for their instructional planning.

Over the course of the first round of observations, technical problems were resolved and almost totally eliminated. When a school was identified as needing technical support and assistance, this information was fed-back to the DPI and follow-up was provided. For example, computer vendors were contacted if hardware was the problem, the DPI provided technical assistance

to help implement software and address software problems, and visits among project staff were facilitated.

In terms of teaching writing, these observations indicated that all teachers were focusing their instruction on the writing process and a few teachers were using a mini-lesson format. However, in discussions with teachers, most indicated that they did use mini-lessons on a regular basis, but use of such lessons varied with the class and assignment. Also, approximately half of the teachers were observed conferencing with individual students. Again, it was not expected that all students would be observed to be at this stage in the writing process. In several classes students were observed conferencing with each other, an activity which some teachers were using prior to or in lieu of student-teacher conferencing. This strategy seemed to work well; students appeared to enjoy the "author-to-author" interaction with their peers and to have the necessary skills to provide helpful feedback. Overall, teachers were observed providing extensive individual monitoring and assistance to students working on their writing assignments and also to students working on computers.

Observations concerning computer use were also very positive. Teachers had developed a system for scheduling all students to be on the computer one or more times a week, usually to work on and complete at least one assignment. In many classes the schedule was posted. Teachers had from six to ten computers available (and 1 or 2 printers), and they were all in use during each observation, by one or two students, for an average of 30 minutes.

Teachers were observed trying out two different instructional strategies for incorporating computer use into their English classes. Some had all students working on the same writing assignment, with some students completing the assignment on the computer. Others had groups of students

and RBS recommendations for continuing the project; and, RBS summarized the observation findings and discussed the evaluation and documentation plans. Several teachers even shared their students' writing and special class writing projects. Teachers informally reported these dinner meetings to be very helpful and welcomed the opportunity to meet and share information with other project teachers.

Did the original program implementations continue and what mitigated against/fostered continuation/expansion? The follow-up survey was completed by 14 of the 16 project teachers; six completed the survey during the May 1991 meeting and eight teachers completed the survey by mail. All respondents indicated that their students continued to use the computer, on a rotating basis, to work on writing assignments, and in addition to drafting and editing, six teachers reported that students' computer work also focused on pre-writing. All respondents also indicated that they continued to use on a daily basis the writing process approach, and thirteen respondents reported that they continued to use mini-lessons and to monitor students' computer use on a regular basis. Twelve of the teachers responding reported that they continued to use conferencing on a routine basis with individuals or small groups of students. With few exceptions, the reported levels of implementation of these five program elements were equal to or greater than those of the previous year. Interestingly, nine teachers reported that they were much more comfortable using the computers for writing instruction during the 1990-1991 school year.

Teachers were asked about expansion within and outside of project classes. The hardware and software used by project teachers were basically the same as that used in year one, even in cases where the district provided funds for purchasing additional software. However, four respondents

indicated that the program spread to other classes within their school. In one case, the program spread was to other teachers in the same building. In a second case, the expansion was a district rather than a project effort. A third teacher indicated there was minimal spread to other teachers (due to the limited number of computers). The fourth case was expansion as a result of the project teacher presenting an elective computer writing course.

The following factors were most often cited by teachers as supporting the continuation of their computer writing programs during the 1990-1991 school year: support from school or district in terms of hardware, software, supplies, equipment maintenance, and training; teachers' increased knowledge and comfort; and student interest in and support of the project. Factors reported as mitigating against continued implementation and expansion were: the limited number of computers; lack of school or district support for hardware, supplies, maintenance, and training; large class size and shortened length of class period; and lack of student interest in and support of the practice.

Outcome Evaluation Results

Three outcome evaluation questions were specified in the design of the study as described earlier. The findings with respect to each of these are presented below.

Were student writing skills enhanced as a result of participation in the project? Student writing skills were assessed for experimental and control students on a pre- and posttest basis. All pre- and post-writing assessments were sent to an independent third party for scoring (CTB MacMillan/McGraw-Hill). A total of 5,887 papers were scored. The scoring system involved four analytic factors: focus, organization, development, and language conventions. The focus factor was used to assess the clarity

and point or subject and its appropriateness to the audience and purpose as specified by the prompt. The organization factor dealt with the clarity and effectiveness of the plan or arrangement of ideas and the use of organizational methods or strategies appropriate to the audience and purpose of the prompt. The development factor involved the elaboration of the main point or subject using examples, specific details, and supporting information. The conventions factor was used to assess the correct use of standard English including grammar, sentence structure, spelling, punctuation, and capitalization.

The factors were scored on a six-point scale according to separate sets of criteria and recorded as four independent scores plus an equally weighted total score. The six-point scale ranged as follows: (1) seriously deficient, (2) moderately deficient, (3) slightly deficient, (4) moderately proficient, (5) proficient, and (6) exceptionally proficient. Specific criteria for review of each factor are presented in the appendix. All papers were scored by two independent readers, and discrepancies (papers with score differences of more than one point) were scored a third time (adjudicated) by table leaders. Practice sets and validation packs were developed and used for training of scorers. Scoring procedures employed initial training, practice sample scoring, validation procedures and consistency checks. Reader reliability checks were made and reports issued beginning with the second day of scoring. Condition codes were recorded in place of scores when one of the following response conditions were encountered during scoring: (A) blank, (B) illegible, (C) off topic, (D) insufficient to score, or (E) predominately in another language.

A final score was arrived at for each of the four factors, and a total score consisting of the sum of the final four factor scores was calculated.

In obtaining these scores, certain guidelines were followed. If there were only two readings, the final score was simply the average of the two reading scores. If a third reading was necessary, the final sore was the third reading score. If the same condition code was given for the two reading scores, the condition code was used as the final score. However, if two different condition codes were given or a numerical code and a condition code were given, the final score was the third reading score. The total score was computed as the sum of the four factor scores, with condition codes assigned a value of zero.

Two approaches were used in the analysis of the data on student writing skills. The first involved an analysis of covariance of mean writing posttest scores comparing experimental and control group students across all schools. Table 1 shows the results of this analysis. The second approach analyzed program effects by comparing gains for the experimental and the corresponding control group within each school. The results of this latter approach are shown in Tables 2 - 6. In comparing gains for the experimental and control group within each school, schools not having a control group were evaluated by using the overall control group school mean in place of what would have been the school's control group.

Table 1 shows results of an analysis of covariance of posttest writing assessment scores using the pretest as a covariate. Separate analyses were conducted for each score. Results show the total number of subjects analyzed (N), the adjusted posttest means for experimental (X) and control (C) groups, the F value (F), and the level of statistical significance obtained (Sig.).

As can be seen in Table 1, the results reflect very favorably on the experimental program Results of comparisons between experimental and

Table 1

Analysis of Covariance of Post Student Writing Assessment
(using Pretest as the Covariate)

Score	N	Adjusted Posttest Mean X	Adjusted Posttest Mean C	F	Sig.
Total	2285	16.11	15.82	9.34	.002
Focus	2275	4.18	4.15	1.78	NS
Organization	2285	3.93	3.83	13.13	.001
Development	2285	3.97	3.90	4.79	.02
Conventions	2285	4.03	3.96	8.89	.003

X = Experimental
C = Control

Table 2

Writing Assessment Gains By School

(Total Score)

School	Group *	N	Pre	Post	Gain	t-sig	Gr. Gain
[A]	X	84	15.80	16.07	.27	NS	X
	C	158	16.10	15.72	- .38	.05	
[B]	X	47	15.17	15.91	.74	.01	X
	C	65	16.24	16.28	.04	NS	
[C]	X	74	13.44	14.47	1.03	.001	X
	C	83	15.28	15.87	.59	----	
[D]	X	81	14.14	15.70	1.56	.001	C
	C	201	14.85	16.48	1.63	.001	
[E]	X	89	13.54	17.18	3.64	.001	X
	C	60	15.63	17.08	1.45	.001	
[F]	X	82	13.41	14.79	1.38	.001	X
	C	81	13.98	14.85	.86	.001	
[G]	X	108	17.05	18.01	.96	.001	X
	C	36	16.05	15.58	- .47	NS	
[H]	X	107	13.36	14.74	1.38	.001	X
	C	83	15.28	15.87	.59	----	
[I]	X	49	17.71	18.98	1.27	.001	X
	C	38	15.91	16.20	.29	NS	
[J]	X	22	14.68	14.41	- .27	NS	C
	C	83	15.28	15.87	.59	----	
[K]	X	89	15.00	14.80	- .20	NS	C
	C	49	14.95	16.20	1.25	.01	
[L]	X	58	16.45	16.89	.44	NS	C
	C	97	15.04	16.30	1.26	.001	
[M]	X	67	16.78	16.87	.08	NS	C
	C	35	15.60	16.11	.51	NS	
[N]	X	98	14.96	15.91	.95	.001	X
	C	17	15.15	15.56	.41	NS	
[O]	X	67	13.44	14.75	1.31	.001	X
	C	141	15.58	15.73	.15	NS	
[P]	X	59	15.09	17.06	1.97	.001	X
	C	107	13.60	14.29	.69	.01	
MEANS	X	74	15.00	16.03	1.03		11=X
	C	83	15.28	15.87	.59		5=C

X=Experimental
C=Control

Table 3

Writing Assessment Gains By School

(Focus Score)

School	Group*	N	Pre	Post	Gain	t-sig	Gr. Gain
[A]	X	84	4.12	4.21	.09	NS	X
	C	158	4.19	4.12	- .07	NS	
[B]	X	47	4.04	4.11	.07	NS	X
	C	65	4.24	4.28	.04	NS	
[C]	X	74	3.58	3.80	.22	.005	X
	C	----	----	----	.18	----	
[D]	X	81	3.76	4.12	.36	.001	C
	C	201	3.90	4.29	.39	.001	
[E]	X	88	3.59	4.44	.85	.001	X
	C	60	4.05	4.50	.45	.001	
[F]	X	82	3.55	3.85	.30	.001	X
	C	81	3.71	3.91	.20	.001	
[G]	X	108	4.41	4.65	.24	.001	X
	C	34	4.26	4.11	.15	NS	
[H]	X	107	3.63	3.86	.23	.001	X
	C	----	----	----	.18	----	
[I]	X	49	4.61	4.86	.25	.05	X
	C	38	4.08	4.11	.03	NS	
[J]	X	22	3.77	3.79	.02	NS	C
	C	----	----	----	.18	----	
[K]	X	89	3.92	3.85	- .07	NS	C
	C	49	3.89	4.22	.33	.01	
[L]	X	57	4.39	4.44	.05	NS	C
	C	96	3.95	4.29	.34	.001	
[M]	X	67	4.40	4.44	.04	NS	C
	C	35	4.03	4.16	.13	NS	
[N]	X	97	3.98	4.09	.11	NS	C
	C	17	3.94	4.09	.15	NS	
[O]	X	67	3.63	3.89	.26	.005	X
	C	141	4.07	4.09	.02	NS	
[P]	X	58	3.98	4.40	.42	.001	X
	C	105	3.62	3.74	.12	NS	
MEANS	X	74			.22		10=X
	C	83			.18		6=C

X = Experimental
C = Control

Table 4

Writing Assessment Gains By School

(Organization Score)

School	Group*	N	Pre	Post	Gain	t-sig	Gr. Gain
[A]	X	84	3.84	3.98	.14	NS	X
	C	158	3.90	3.81	- .09	NS	
[B]	X	47	3.59	3.85	.26	.005	X
	C	65	3.86	3.95	.09	NS	
[C]	X	74	3.28	3.49	.21	.005	X
	C	----	----	----	.17	----	
[D]	X	81	3 36	3.86	.50	.001	X
	C	201	3.59	3.97	.38	.001	
[E]	X	89	3.22	4.27	1.05	.001	X
	C	60	3.82	4.20	.38	.001	
[F]	X	82	3.26	3.59	.33	.001	X
	C	81	3.26	3.58	.32	.001	
[G]	X	108	4.16	4.41	.25	.001	X
	C	36	3.93	3.79	.14	NS	
[H]	X	107	3.18	3.59	.41	.001	X
	C	----	----	----	.17	----	
[I]	X	49	4.29	4.60	.31	.01	X
	C	38	3.87	3.88	.01	NS	
[J]	X	22	3.56	3.45	- .11	NS	C
	C	----	----	----	.17	----	
[K]	X	89	3.63	3.53	- .10	NS	C
	C	49	3.64	3.94	.30	.01	
[L]	X	58	3.97	4.14	.17	.05	C
	C	97	3.69	3.97	.28	.001	
[M]	X	67	4.06	4.10	.04	NS	C
	C	35	3.77	3.90	.13	NS	
[N]	X	98	3.57	3.88	.31	.001	X
	C	17	3.65	3.74	.09	NS	
[O]	X	67	3.17	3.62	.45	.001	X
	C	141	3.77	3.79	.02	NS	
[P]	X	59	3.64	4.17	.53	.001	X
	C	107	3.26	3.46	.20	.005	
MEANS	X	74			.30		12=X
	C	83			.17		4=C

X = Experimental
C = Control

Table 5

Writing Assessment Gains By School

(Development Score)

School	Group*	N	Pre	Post	Gain	t-sig	Gr. Gain
[A]	X	84	3.86	3.87	.01	NS	X
	C	158	3.97	3.79	- .18	.01	
[B]	X	47	3.67	3.88	.21	.05	X
	C	65	4.14	3.98	- .16	NS	
[C]	X	74	3.12	3.51	.39	.001	X
	C	----	----	----	.17	----	
[D]	X	81	3.42	3.85	.43	.001	C
	C	201	3.63	4.13	.50	.001	
[E]	X	89	3.07	4.33	1.26	.001	X
	C	60	3.81	4.27	.46	.001	
[F]	X	82	3.25	3.63	.38	.001	X
	C	81	3.49	3.64	.15	.05	
[G]	X	108	4.32	4.52	.20	.005	X
	C	36	4.03	3.86	.17	NS	
[H]	X	107	3.15	3.60	.45	.001	X
	C	----	----	----	.17	----	
[I]	X	49	4.43	4.83	.40	.001	X
	C	38	3.82	4.03	.21	.05	
[J]	X	22	3.72	3.45	- .27	NS	C
	C	----	----	----	.17	----	
[K]	X	89	3.80	3.84	.04	NS	C
	C	49	3.72	4.07	.35	.005	
[L]	X	58	4.12	4.20	.08	NS	C
	C	97	3.75	4.09	.34	.001	
[M]	X	67	4.12	4.06	- .06	NS	C
	C	35	3.89	3.97	.08	NS	
[N]	X	98	3.64	3.90	.26	.005	X
	C	17	3.76	3.76	.00	NS	
[O]	X	67	3.23	3.60	.37	.001	X
	C	141	3.82	3.86	.04	NS	
[P]	X	59	3.64	4.16	.52	.001	X
	C	107	3.32	3.55	.23	.005	
MEANS	X	74			.29		11=X
	C	83			.17		5=C

X = Experimental

C = Control

Table 6

Writing Assessment Gains By School

(Conventions Score)

School	Group*	N	Pre	Post	Gain	t-sig	Gr. Gain
[A]	X	84	3.99	4.02	.03	NS	X
	C	158	4.04	4.01	- .03	NS	
[B]	X	47	3.86	4.06	.20	.01	X
	C	65	3.99	4.06	.07	NS	
[C]	X	74	3.47	3.68	.21	.005	X
	C	----	----	----	.14	----	
[D]	X	81	3.60	3.87	.27	.001	C
	C	201	3.72	4.08	.36	.001	
[E]	X	89	3.66	4.18	.52	.001	X
	C	60	3.95	4.11	.16	.05	
[F]	X	82	3.40	3.73	.33	.001	X
	C	81	3.53	3.72	.19	.005	
[G]	X	108	4.15	4.42	.27	.001	X
	C	36	3.99	3.93	- .06	NS	
[H]	X	107	3.39	3.68	.29	.001	X
	C	----	----	----	.14	----	
[I]	X	49	4.38	4.69	.31	.005	X
	C	38	4.14	4.18	.04	NS	
[J]	X	22	3.61	3.70	.09	NS	C
	C	----	----	----	.14	----	
[K]	X	89	3.80	3.84	.04	NS	C
	C	49	3.69	3.97	.28	.005	
[L]	X	58	4.04	4.18	.14	NS	C
	C	97	3.70	3.97	.27	.001	
[M]	X	67	4.19	4.25	.06	NS	C
	C	35	3.91	4.08	.17	NS	
[N]	X	98	3.78	4.09	.31	.001	X
	C	17	3.79	3.97	.18	NS	
[O]	X	67	3.40	3.62	.22	.005	X
	C	141	3.92	3.98	.06	NS	
[P]	X	59	3.90	4.31	.41	.001	X
	C	107	3.47	3.54	.07	NS	
MEANS	X	74			.23		11=X
	C	83			.14		5=C

X = Experimental
C = Control

control groups on organization, development, conventions and total scores show statistically significant differences favoring the experimental program. Only the focus score failed to show a significant difference.

An examination of Tables 2 - 6 shows similarly favorable results at the individual school level. In these tables, experimental and control groups for each individual school are shown. For each group, the number of subjects (N) with complete pre- and posttest records is shown. Also shown are the mean pre- and posttest score and the gain (Gain) or difference score. The results of a correlated t-test (t-sig) comparing pre- and posttest scores are also represented in terms of the significance level reached. Finally, the group with the greater gain (Gr. Gain) is identified in the final column of the tables. For each score type listed in these tables, the number of cases where experimental school groups gained more than the control groups exceeded by a wide margin the number of cases in which the controls outgained the experimentals.

Thus, the weight of evidence indicated by the findings supports the contention that the computer writing program does indeed serve to enhance the writing skills of participating students.

Did students get more enjoyment of writing as a result of participation in the project? Student enjoyment of writing was assessed using a single question on the student attitude survey administered to both experimental and control groups on a pre- and posttest basis. The question content and analysis results are given below.

Question: Do you enjoy working on writing assignments?

1. Almost Always
2. Often
3. Sometimes
4. Rarely
5. Never

Group	N	Pre	Post	Gain	t-sig	Gr. Gain
X	1119	2.90	2.67	- .23	.001	X
C	1099	3.07	3.08	+ .01	NS	

Since the response scale for the item is arranged from "1 = Almost Always" to "5 = Never," movement from a higher pretest mean to a lower posttest mean is interpreted to be a more favorable response (i.e., a gain in enjoyment). As can be seen by the results, only the experimental group gained in its enjoyment of writing from the beginning to the end of the academic year, and this gain was substantial as well as being statistically significant. On-site observations and discussions with teachers and students at the experimental group sites also confirmed that experimental students gained in their enjoyment of the writing process.

Did students enjoy using the computer for learning and practicing writing skills? Student enjoyment of use of the computer for learning and practicing writing skills was also assessed using a single item on the student survey. The survey question and the results for experimental and control groups are presented below.

Question: Do you enjoy using a computer for writing?

1. Almost Always
2. Often
3. Sometimes
4. Rarely
5. Never

Group	N	Pre	Post	Gain	t-sig	Gr. Gain
X	1113	2.39	1.70	- .69	.001	X
C	1095	2.78	2.66	- .12	.01	

The response scale ranges from a "1 = Almost Always" to a "5 = Never", and thus changes in the direction of more enjoyment from pre- to posttest would result in a negative difference score. The magnitude of the negative

difference score would indicate the extent of the more favorable change experienced.

As can be seen by the above results, the experimental program group shows a gain in enjoyment of computer use for learning and practicing writing skills. The gain is also more than five times that of the control group. This is to be expected since the exposure of the control group students to computers for use in writing on a formal basis was to have been of a limited nature.

It is clear, then, that the experimental program group enjoyed using the computers. On-site observations and discussions with teachers and students served to confirm this finding as well.

Conclusions and Implications

Based on the evaluation study of the computer writing program, several conclusions can be drawn.

- In general, adequate orientation and training were provided to the participating schools as well as help in selecting and acquiring computer hardware and software.
- Most program sites started on time and implemented the program as planned.
- Despite all efforts, a few of the schools did not take advantage of the special training opportunities and technical assistance services and, in some cases, struggled somewhat during implementation as a consequence.
- It appears that on-site visitation and monitoring of the first year of implementation of a computer writing program is essential to its success and continuation.
- Student writing skills are enhanced through use of computers within the context of a process approach to writing.
- Students enjoy writing more when using computers in conjunction with their normal writing instruction program.
- Students enjoy using the computer for learning and practicing their writing skills.

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